National Park Service (NPS) Comments[1] on
Arizona Public Service (APS)'s Proposed
Best Available Retrofit Technology (BART) Determination for
Four Corners Power Plant (FCPP)
November 20, 2009

Present Unit Operation

The Four Corners Power Plant (FCPP) is operated by Arizona Public Service (APS) and burns mine-mouth bituminous coal. FCPP is located on the Navajo Nation and approximately 50 km from Mesa Verde National Park (NP). The plant is located within 300 km of 16 Class I areas,[2] which also include Arches, Bandelier, Black Canyon, Canyonlands, Capitol Reef, Grand Canyon, Great Sand Dunes, and Petrified Forest National Parks (which are also Class I areas administered by the National Park Service).

Source Description and Background

Units 1 through 3 are sub-critical, front wall-fired boilers and are equipped with Venturi scrubbers for sulfur dioxide (SO_2) and particulate Matter (PM) control. Units 4 and 5 are super-critical cell-burners and are equipped with wet scrubbers for SO_2 removal and reverse-gas fabric filters for PM control. Unit 1 had burner modifications performed in 1977 for NO_X purposes, while Units 3, 4, and 5 are equipped with late-1980s vintage Low-NO_x Burners (LNBs), and Unit 2 had LNBs installed in 1998.

According to EPA's Clean Air Markets (CAM) database, FCPP was the second-largest stationary source of NO_x (out of 1,228 plants) in the U.S. in 2008 at 40,311 tons. FCPP also ranked #29 for the highest NO_x emissions per unit of heat input. The table below shows how individual units at FCPP rank compared to 3,558 Electric Generating Units (EGUs) included in the CAM database for 2008:

UNIT ID	NO_X RATE		NO_X MASS		HEAT INPUT
	(lb/mmBtu)	Rank	(tons)	Rank	(mmBtu)
1	0.76	35	5,215	161	13,448,000
2	0.64	60	4,617	194	14,227,354
3	0.59	75	6,558	101	22,136,687
4	0.50	129	13,935	7	55,776,903
5	0.48	143	9,987	29	40,765,124
Totals	**0.55**	**29**	**40,311**	**2**	**146,354,068**

[1] Referenced Appendices are included as electronic files on attached disk.
[2] Please see the attached map titled "Visibility Improvement at Class I Areas from SCR Controls at Four Corners PP."

Both APS' and our analyses indicate that FCPP **causes or contributes to** visibility impairment in all 16 Class I areas within 300 km. (The differences between the two analyses will be discussed later.)

APS Baseline Emissions Visibility Impacts

	8th High delta dv			
Class I Area	**2001**	**2002**	**2003**	**Average**
Arches NP	2.13	1.87	1.93	1.98
Bandelier WA	1.62	1.98	1.54	1.71
Black Canyon of the Gunnison WA	1.15	1.63	1.54	1.44
Canyonlands NP	2.46	2.16	2.13	2.25
Capitol Reef NP	2.26	1.45	1.51	1.74
Grand Canyon NP	1.47	0.87	0.89	1.07
Great Sand Dunes NM	0.83	1.32	0.92	1.02
La Garita WA	1.38	1.47	1.24	1.36
Maroon Bells Snowmass WA	0.84	0.82	0.77	0.81
Mesa Verde NP	2.94	3.47	3.11	**3.17**
Pecos WA	1.59	1.59	1.47	1.55
Petrified Forest NP	1.22	1.45	0.95	1.21
San Pedro Parks WA	2.10	2.46	2.07	2.21
Weminuche WA	1.65	2.26	1.78	1.90
West Elk WA	1.09	1.43	1.13	1.22
Wheeler Peak WA	1.19	1.23	1.16	1.20
Totals	**25.89**	**27.46**	**24.15**	**25.83**

Baseline Visibility Impacts predicted by NPS using NPS emission estimates

	8th High delta dv			
Class I Area	**2001**	**2002**	**2003**	**Average**
Arches NP	4.790	4.323	3.551	4.221
Bandelier WA	2.639	3.485	2.906	3.010
Black Canyon of the Gunnison WA	2.488	2.909	3.017	2.805
Canyonlands NP	6.503	5.988	5.364	5.952
Capitol Reef NP	5.038	2.717	2.519	3.425
Grand Canyon NP	3.053	1.889	1.542	2.161
Great Sand Dunes NM	1.135	1.491	1.181	1.269
La Garita WA	1.576	1.911	1.925	1.804
Maroon Bells Snowmass WA	1.117	1.109	1.191	1.139
Mesa Verde NP	5.791	6.712	6.168	**6.224**
Pecos WA	1.946	2.601	2.045	2.197
Petrified Forest NP	1.509	2.053	1.334	1.632
San Pedro Parks WA	3.912	4.210	3.792	3.971
Weminuche WA	2.296	1.892	2.193	2.127
West Elk WA	2.406	3.450	2.850	2.902
Wheeler Peak WA	1.805	1.894	1.543	1.747
Totals	**48.004**	**48.634**	**43.121**	**46.586**

Our analysis indicates that FCPP causes the greatest cumulative impact upon Class I area visibility of any single source we have evaluated to date.

Before we discuss the NO_x BART proposals on a unit-by-unit basis, we will discuss some overarching issues related to the five-step BART analyses.

Step 1 – Identify all available retrofit control technologies
APS should have included tail-end SCR in its suite of options.

Step 2 – Eliminate technically infeasible options
With the exception noted above, we agree with APS' selections.

Step 3 – Evaluate the control effectiveness of the remaining technologies
APS has estimated that combustion controls such as LNB and Over-Fire Air (OFA) can reduce NO_x emissions by 29% - 45% at FCPP and we agree.

APS Estimates of Proposed Combustion Control Effectiveness

Unit	**FCPP #1**	**FCPP #2**	**FCPP #3**	**FCPP #4**	**FCPP #5**
Proposed Controls	LNB	LNB	LNB+OFA	LNB+OFA	LNB+OFA
Current Emissions (tpy)	5,703	4,788	5,633	13,028	13,028
Current Emission Rate (lb/mmBtu)	0.78	0.64	0.59	0.49	0.49
Control Efficiency	**45%**	**33%**	**44%**	**29%**	**29%**
New Emission Rate (lb/mmBtu)	0.43	0.43	0.33	0.35	0.35
New Emissions (tpy)	3,134	3,215	3,168	9,230	9,230
Emissions Reduction (tpy)	2,569	1,573	2,465	3,798	3,798

We also agree with APS that Selective Catalytic Reduction (SCR) by itself can reduce NO_x emissions by 88% - 91% at FCPP. However, when APS estimated the combination of combustion controls plus SCR, it effectively assumed that SCR could only further reduce NO_x by 82% - 83%, down to 0.06 lb/mmBtu for each of the five units at FCPP. We believe that SCR can achieve lower emissions on an annual basis.

APS Estimates of Combustion Control + SCR Effectiveness

Unit	**FCPP #1**	**FCPP #2**	**FCPP #3**	**FCPP #4&#5**
Current Emissions (tpy)	5,703	4,788	5,633	13,028
Current Emission Rate (lb/mmBtu)	0.78	0.64	0.59	0.49
Proposed Controls	LNB	LNB	LNB+OFA	LNB+OFA
Control Efficiency	58%	48%	44%	29%
New Emission Rate (lb/mmBtu)	0.33	0.33	0.33	0.35
New Emissions (tpy)	2,405	2,467	3,168	9,230
Emissions Reduction (tpy)	3,298	2,321	2,465	3,798
SCR addition	SCR	SCR	SCR	SCR
SCR Control Efficiency	**82%**	**82%**	**82%**	**83%**
New Emission Rate (lb/mmBtu)	**0.06**	**0.06**	**0.06**	**0.06**
New Emissions (tpy)	437	448	576	1,583
Emissions Reduction (tpy)	1,968	2,019	2,592	7,647

EPA's Clean Air Markets (CAM) data (Appendix A), state/source BART analyses,[3] and vendor guarantees[4] show that SCR retrofit to coal-fired EGUs can typically meet 0.05 lb/mmBtu (or lower) on an annual average basis. We found 34 examples (Please see Table A.1. in Appendix A.) of boilers that have been retrofitted with SCR and are achieving ozone-season emission rates below 0.06 lb/mmBtu. We were able to find 2006 hourly emissions in EPA's CAM database for 11 of those EGUs, and charts showing those emissions, as well as for 11 additional retrofit SCRs, are included in Appendix A. We believe that inspection of this data leads to the conclusions that

- SCRs retrofit to eastern EGUs burning bituminous coal can typically reduce NO_x emissions by 90%, and
- These units can achieve 0.05 lb/mmBtu (or lower) on a 30-day rolling average basis during the eastern ozone season.

Discussions of this data are also provided in Appendix A. The following table summarizes our estimates of overall control effectiveness.

NPS Estimates of Combustion Control + SCR Effectiveness

Unit	**#1**	**#2**	**#3**	**#4**	**#5**
Current Emissions (tpy)	5,812	4,682	5,912	14,032	12,798
Current Emission Rate (lb/mmBtu)	0.79	0.62	0.60	0.52	0.50
Proposed Controls	LNB	LNB	LNB+OFA	LNB+OFA	LNB+OFA
Control Efficiency	58%	47%	45%	33%	29%
New Emission Rate (lb/mmBtu)	0.33	0.33	0.33	0.35	0.35
New Emissions (tpy)	2,416	375	3,270	9,433	9,030
Emissions Reduction (tpy)	3,395	2,207	2,642	4,599	3,768
SCR Control Efficiency	85%	85%	85%	86%	86%
New Emission Rate (lb/mmBtu)	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**
New Emissions (tpy)	366	375	495	1,348	1,290
Emissions Reduction (tpy)	2,050	2,099	2,775	8,085	7,740

APS has not provided any documentation or justification to support the higher values used in its analyses. Our review of operating data (Appendix A) also suggests that a NO_X limit of 0.06 lb/mmBtu is appropriate for LNB/OFA+SCR for a 30-day rolling average, and 0.07 lb/mmBtu for a 24-hour limit and for modeling purposes, but a lower rate (e.g., 0.05 lb/mmBtu or lower) should be used for annual average and annual cost estimates.

STEP 4 –Evaluate Impacts and Document the Results[5]

(The following is excerpted—with emphasis added—from the Black & Veatch (B&V) engineering consultant report to APS.)

[3] Basin Electric Power—Leland Olds #2 @ 90%; PacifiCorp Naughton #1 @ 88% & #2 @ 87%; TransAlta-Centralia 95%; Great River Energy—Coal Creek @ 0.043 lb/mmBtu

[4] Minnesota Power has stated in its Taconite Harbor BART analysis that "The use of an SCR is expected to achieve a NO_X emission rate of 0.05 lb/mmBtu based on recent emission guarantees offered by SCR system suppliers."

[5] We are not using the "BART ANALYSIS CONCLUSIONS–Updated December 2008" submitted by APS because they are completely lacking any supporting justification or documentation. Furthermore, costs have declined since 2008 and are not properly reflected in that document.

Four Corners Units 1 and 2 are front wall-fired Riley furnaces, which have a relatively small furnace volume compared to other wall-fired furnaces. The smaller furnace leads to higher furnace temperatures, less volume available for combustion staging and potential operational challenges (such as slagging) when implementing LNB and/or OFA. The potential SCR retrofit appears particularly difficult, because of the horizontal air heater arrangement, and will require new forced draft (FD) fans, new air heaters, and new induced draft (ID) fans. This leads to an expensive cost, on a dollar per ton of NO_X removed basis, for the SCRs on Units 1 and 2. **Combustion controls are expected to be integral in any NO_X solution because of the relatively high NO_X baseline.** However, the plant experience with LNB on Unit 2 demonstrates that a combustion optimization approach to NO_X reduction must be cognizant of the challenges posed by the small furnaces.

Units 1 and 2 are sister units and share many characteristics that make NO_x retrofits challenging. **Unit 2, however, presents the further challenge of limited footprint area available for retrofits.** Located tightly between Units 1 and 3, with a coal conveyor running on its north side, the access and available area for Unit 2 is extremely limited. The OFA system, which does not require a large footprint, is the least expensive method of reducing NO_x, while the SCR is the most expensive due to the large capital cost associated with the very difficult retrofit.

Units 1 and 2 are both Riley wall fired boilers, with 170 MW net generation capacities. The main difference between the units is that an LNB was installed on Unit 2 in 1998. With a NO_x emissions rate of 0.64 lb/mmBtu as the Unit 2 baseline, NO_x production is about 20 percent lower than Unit 1. **Additionally, the current LNB on Unit 2 has caused operational issues due to furnace constraints and poor combustion.** Similar to Unit 1, the Unit 2 SCR system is more expensive than a typical SCR installation because of the ductwork arrangement around the air heater. **The only feasible option for the installation of an SCR system on Units 1 and 2 is the demolition of the existing air heaters, the installation of new FD fans, and the construction of new air heaters along with the SCR and the corresponding ductwork.** This effort is both capital and labor intensive, resulting in the high cost for SCR implementation.

The characteristics of the Unit 1 and Unit 2 furnaces make the reduction of NO_x by combustion methods difficult. The small furnaces do not allow for effective combustion staging, and the closely-spaced burners reduce the effectiveness of LNB. The LNB with OFA, LNB with OFA plus High Energy Regent Technology (HERT), and SCR reduce NOx at a cost of $519, $814, and $4,401 per ton, respectively.

Unit 3 is slightly larger than Units 1 and 2, but the NO_x BART analysis is very similar for the three units. Unit 3 was also retrofit with LNB and has current NO_x emissions of 0.59 lb/mmBtu. In fact, because of this retrofit, the annual NO_x tons emitted from Unit 3 are lower than the emissions from Unit 1. **Because of the air heater arrangement, the construction of an SCR system is not possible without the installation of a new air heater and new FD fans. These replacement equipment costs, along with the limited area for construction, make the installation of SCR more expensive than a typical**

SCR retrofit. The retrofit of Unit 3 with LNB and OFA represents the economic optimum, at a cost of $397 per ton of NO_x removed. **If more aggressive NO_x reduction is found to be necessary as a result of modeling the visibility impacts**, the LNB, OFA, and HERT system appears to be the next most stringent option, at a cost of $759 per ton removed. The SCR alternative is the most expensive option, at a cost of $3,947 per ton removed.

For the purposes of the BART analysis, Units 4 and 5 were considered to be identical units. This assumption was made because the boilers are sister units, and the history of NO_x modifications is the same for both units. Units 4 and 5 have the same gas path and have nearly identical performance and NO_x emissions rates. The main difference between the Units 1, 2, and 3 BART analysis and the Units 4 and 5 BART analysis is that the HERT and Mobotec technologies are not proven on units as large as Units 4 and 5. **The removal of the intermediate NO_x removal options refines the analysis in such a way that the results of the modeling will play a key role on the determination of the BART technology.** The LNB and OFA option is capable of reducing NO_x at the cost of $792 per ton. By contrast, the SCR system is the least cost-effective option for NO_x reduction, with each ton removed costing $4,499 per ton. This translates to an incremental NO_x reduction cost of $8,099 per ton of NO_x removed beyond the capability of the LNB, OFA, and SNCR. **The SCR retrofit would be extremely complicated and costly because of the arrangement of the primary and secondary air heaters and the corresponding ductwork.** The outage is expected to be significant, with at least 14 weeks of downtime.

The B&V engineering report provided more narrative details concerning the difficulties in reducing NO_x at FCPP than we typically see and we commend them for that. Furthermore, the B&V report underscores the reasons for the relatively high NO_x emissions rankings of the FCPP EGUs by highlighting the factors that cause these EGUs to emit much more NO_x on a lb/mmBtu basis than other EGUs. Finally, the B&V report highlights the need for NO_x controls that are more aggressive than proposed by APS if truly significant NO_x reductions are justified by the modeling results (as repeatedly noted by B&V). Following are summaries of APS' cost estimates for its proposed combustion controls plus SCR.

APS Estimates of Proposed Combustion Control Costs

Unit	FCPP #1	FCPP #2	FCPP #3	FCPP #4	FCPP #5	Totals
Rating (MW Gross)	185	185	235	790	790	2,185
Emissions Reduction (tpy)	2,569	1,573	2,465	3,798	3,798	14,203
Capital Cost	$3,823,000	$3,823,000	$4,359,000	$13,320,000	$13,320,000	$38,645,000
Capital Cost ($/kW)	$21	$21	$19	$17	$17	$18
O&M Cost	$357,017	$357,000	$409,264	$1,276,000	$1,276,000	$3,675,281
Total Annual Cost	$857,000	$857,000	$979,000	$3,008,000	$3,008,000	$8,709,000
Cost-Effectiveness ($/ton)	$334	$545	$397	$792	$792	$613

APS Estimates of Combustion Control + SCR Costs

Unit	FCPP #1	FCPP #2	FCPP #3	FCPP #4	FCPP #5	Totals
Rating (MW Gross)	185	185	235	790	790	2,185
Emissions Reduction (tpy)	5,266	4,340	5,057	11,445	11,445	37,553
Capital Cost	$90,193,000	$97,045,000	$98,582,000	$254,313,000	$254,313,000	$794,446,000
Capital Cost ($/kW)	$488	$326	$269	$226	$226	$364
O&M Cost	$4,843,000	$5,043,95	$5,866,000	$17,159,000	$17,159,000	$45,027,000
Total Annual Cost	$17,750,000	$18,983,000	$19,795,000	$52,682,000	$52,682,000	$161,892,000
Cost-Effectiveness ($/ton)	$3,371	$4,374	$3,914	$4,603	$4,603	$4,311

However, we have a major concern with the way in which B&V estimated the costs of adding SCR at FCPP, and believe those costs are overestimated.[6] According to B&V:

> To perform the economic analysis, capital and annual operating cost estimates were developed for each of the emissions control alternatives. The capital cost estimates were based on the Coal Utility Environmental Cost (CUECost) generated estimates, cost data supplied by equipment vendor (budget estimates), estimates from previous in-house design/build projects, and projected costs from APS Four Corners Generating Station. The annual operating cost estimates were based on operation at full load conditions. The annual operating costs covered increases in fan auxiliary power requirements, additional labor requirements, water costs, waste product disposal costs, and additional costs for consumables. The cost calculations are included in Appendix D.

While B&V did present "line item" costs for SCR, it is not possible to determine from the information provided how those "line item" costs were derived. According to B&V:

> To obtain an estimate of the costs of compliance, the total capital investment (TCI) for each control technology when applied specifically to Units 1 through 5 was calculated. The bases for this cost calculation were the following:
> • CUECost Workbook, Version 1.0.
> • *EPA Air Pollution Control Cost Manual*, Sixth Edition.
> • Budgetary quotes from equipment vendors.
> • References to quotes or cost estimations for previous design/build projects or in-house estimates.

Instead of CUECost and internal and proprietary databases, the BART Guidelines recommend use of the EPA Control Cost Manual:

> The basis for equipment cost estimates also should be documented, either with data supplied by an equipment vendor (i.e., budget estimates or bids) or by a referenced source (such as the OAQPS Control Cost Manual, Fifth Edition, February 1996, 453/B-96-001). In order to maintain and improve consistency, cost estimates should be based on the OAQPS Control Cost Manual, where possible. The Control Cost Manual addresses most control technologies in sufficient detail for a BART analysis. The cost analysis should also take into account any site-specific design or other conditions identified above that affect the cost of a particular BART technology option.

[6] This would not be the first time that B&V's costs estimates have been questioned. In December 2007, Eastern Research Group, Inc. (ERG) was engaged by the Oregon Department of Environmental Quality (DEQ) to assist in the evaluation of the Portland General Electric (PGE) BART Proposal and to conduct an independent feasibility assessment of select options for control of NO_x from the coal-fired Boardman Plant. This is an excerpt from ERG's June 2008 report to Oregon DEQ: "ERG's analysis of the 2007 cost for retrofitting SCR at the Boardman Plant is based on literature information and on data provided by PGE and B&V. We find a cost of about $250/kW versus the PGE and B&V estimate of $309/kW to be reasonable in view of recent similar installations and literature estimates."

EPA's belief that the Control Cost Manual should be the primary source for developing cost analyses that are transparent and consistent across the nation and provide a common means for assessing costs is further supported by this November 7, 2007, statement from EPA Region 8 to the North Dakota Department of Health:

> The SO_2 and PM cost analyses were completed using the CUECost model. According to the BART Guidelines, in order to maintain and improve consistency, cost estimates should be based on the OAQPS Control Cost Manual. Therefore, these analyses should be revised to adhere to the Cost Manual methodology.

APS did not provide adequate justification or documentation for its cost estimates, and B&V's application of CUECost does not provide for a transparent method (as does the EPA Control Cost Manual) to determine how the costs were calculated. We were not provided with any vendor estimates or bids for SCR, and B&V did not use the appropriate section of the EPA Control Cost Manual for SCR.[7] As a result, APS' estimates for capital costs are substantially higher than the $50 - $270/kW found in available cost surveys. (Please see "Cost Survey Results" in Appendix B.) While we understand that installation costs may be greater for FCPP due to space constraints, APS should show the extra expenses and how they were estimated.[8] Finally, some of the specific cost items that were provided appear to be much more costly than we typically see in other BART analyses across the nation,[9] and we would particularly like to see actual vendor estimates for catalyst and ammonia costs. For these reasons, we believe that capital and annual costs are overestimated, and we conducted our own analysis using the EPA-recommended EPA Control Cost Manual[10] and derived much lower costs.

NPS Estimates of Combustion Control + SCR Costs

Unit	FCPP #1	FCPP #2	FCPP #3	FCPP #4	FCPP #5	Totals
Rating (MW Gross)	185	185	235	790	790	2,185
Emissions Reduction (tpy)	5,446	4,307	5,417	12,684	11,508	39,361
Capital Cost	$52,793,077	$60,676,814	$54,026,747	$ 113,485,159	$ 113,945,854	$ 394,927,651
Capital Cost ($/kW)	$ 285	$ 328	$ 230	$ 144	$ 144	$ 181
O&M Cost	$ 1,896,917	$ 2,035,967	$ 2,270,190	$ 5,897,139	$ 5,804,109	$ 17,904,321
Total Annual Cost	$ 7,221,813	$ 8,104,955	$ 7,528,210	$ 18,435,022	$ 18,385,478	$ 59,675,476
Cost-Effectiveness ($/ton)	$ 1,326	$ 1,882	$ 1,390	$ 1,453	$ 1,598	$ 1,516

7 B&V appears to have used parts of the OAQPS Control Cost manual that do not pertain to SCR.

8 For example, B&V could use an approach similar to that discussed by William M. Vatavuk on pages 59 – 62 of his book Estimating Costs of Air Pollution Control.

9 For example, we have seen the following operating cost estimates:

- Catalyst = $3,000/cubic meter estimated by PacifiCorp in its BART analyses for its Wyoming EGUs and by TransAlta for the Centralia EGUs versus $6,500/cubic meter estimated by B&V
- Ammonia = $304.45/ton estimated by Basin Electric Power in its 8/2006 BART report to ND versus $420/ton estimated by B&V for urea

10 We attempted to adjust the cost derived by a direct application of the EPA Cost Manual by applying "extra" retrofit factors of 1.5 – 2.0 to the direct and indirect costs. Application of these extra retrofit factors was based upon our interpretation of information provided by B&V and a previous site visit. Our "target" was to keep the capital cost of SCR on Unit #2, the most expensive retrofit (on a $/kW basis), around $300/kW based upon the survey information in Appendix A. Cost for the other EGUs were somewhat proportional to Unit #2 based upon the B&V estimates.

STEP 5 – Evaluate Visibility Impacts

Base Case:

According to APS' modeling consultant, AECOM, Mesa Verde NP is the most-impacted Class I area with an average 98th percentile value of 3.17 deciview (dv), and the cumulative impact across all 16 Class I areas is 25.83 dv.

As discussed in more detail in our analysis of the Navajo Generating Station (NGS),[11] it is likely that AECOM underestimated visibility impacts because it incorrectly assumed that the only Inorganic Condensable Particulate Matter (IOR CPM) is sulfuric acid mist (H_2SO_4). The major difference in PM emissions arises when one estimates IOR CPM instead of only its H_2SO_4 component.

We ran CALPUFF using APS' estimates for SO_2 and NO_x emissions, and our estimates for PM emissions and background ammonia. (All of our emission estimates can be found in Appendix C and our model results in Appendix D.) Our results (Please see page two of this report.) were consistently higher than those of AECOM. Mesa Verde NP continues to be the most-impacted at 6.22 dv and the cumulative impact across all 16 Class I areas is 46.59 dv. We believe that the bulk of these differences is due to our use of a higher (1 ppb) background ammonia concentration.

Option 1 (Combustion Controls):

AECOM: The results show that the regional haze impacts may improve visibility by an average of 0.16 delta-dv (relative to the baseline case) with the installation of LNB on Units 1-2 and LNB/OFA on Units 3-4-5.

APS Option 1 Improvements versus Baseline Visibility Impacts predicted by AECOM

	8th High delta dv			
Class I Area	**2001**	**2002**	**2003**	**Average**
Arches NP	0.23	0.16	0.33	0.24
Bandelier WA	0.13	0.14	0.18	0.15
Black Canyon of the Gunnison WA	0.14	0.23	0.31	0.23
Canyonlands NP	0.17	0.19	0.21	0.19
Capitol Reef NP	0.15	0.24	0.22	0.20
Grand Canyon NP	0.20	0.08	0.09	0.12
Great Sand Dunes NM	0.14	0.33	0.25	0.24
La Garita WA	0.29	0.28	0.27	**0.28**
Maroon Bells Snowmass WA	0.14	0.19	0.13	0.15
Mesa Verde NP	0.13	0.13	0.22	0.16
Pecos WA	0.29	0.25	0.20	0.24
Petrified Forest NP	0.17	0.25	0.05	0.16
San Pedro Parks WA	0.25	0.15	0.12	0.18
Weminuche WA	0.18	0.31	0.24	0.24
West Elk WA	0.20	0.23	0.14	0.19
Wheeler Peak WA	0.24	0.24	0.18	0.22
Totals	3.05	3.39	3.13	**3.19**

[11] Please see our July 24, 2009 letter to Deborah Jordan.

NPS: AECOM has used an approach that is unlike any we have seen anywhere else in the U.S. (except in its NGS analysis). AECOM has presented the average visibility improvement across the 16 Class I areas it modeled. Instead, we believe that AECOM should have evaluated impacts on the most-impacted Class I area as well as cumulative (not average) impacts across all 16 Class I areas. According to AECOM results, Option 1 would reduce FCPP's impacts by 0.28 dv at La Garita WA and by 3.19 dv across the 16 Class I areas.

We re-ran CALPUFF using our estimates for PM emissions and background ammonia. Our results were consistently higher than those of AECOM, and the greatest improvement would be at Canyonlands NP at 0.933 dv. The cumulative improvement would be 8.635 dv.

APS Option 1 Improvements versus Baseline Visibility Impacts predicted by NPS

	8th High delta dv			
Class I Area	**2001**	**2002**	**2003**	**Average**
Arches NP	1.006	0.570	0.597	0.724
Bandelier WA	0.648	0.573	0.380	0.534
Black Canyon of the Gunnison WA	0.612	0.648	0.608	0.623
Canyonlands NP	1.047	1.027	0.724	**0.933**
Capitol Reef NP	0.612	0.725	0.494	0.610
Grand Canyon NP	0.653	0.434	0.359	0.482
Great Sand Dunes NM	0.283	0.353	0.291	0.309
La Garita WA	0.379	0.497	0.510	0.462
Maroon Bells Snowmass WA	0.285	0.275	0.310	0.290
Mesa Verde NP	0.379	0.556	0.680	0.538
Pecos WA	0.459	0.465	0.403	0.442
Petrified Forest NP	0.374	0.492	0.206	0.357
San Pedro Parks WA	0.837	0.561	0.884	0.761
Weminuche WA	0.619	0.445	0.518	0.527
West Elk WA	0.597	0.767	0.542	0.635
Wheeler Peak WA	0.468	0.446	0.307	0.407
Totals	9.258	8.834	7.813	**8.635**

Option 2 (Combustion Controls + selective non-catalytic reduction (SNCR) on Units 4-5):

This option was not proposed by APS and not evaluated by NPS because it is inferior to Option 3.

Option 3 (Combustion Controls + SCR):

AECOM: Addition of SCR is projected to improve visibility by about 0.44 delta-dv from the baseline case, and only about 0.28 delta-dv from NO_x BART control option 1, but at a very substantial cost. The relatively small incremental improvement in visibility is due in part to the small role that nitrates play in the total regional haze contribution. In addition, the installation of SCR would create new emissions of primary sulfates and excess ammonia, partially offsetting any available NO_x reduction benefit to visibility. This is especially true during the high visitation period of the warm weather months, when nitrates have minimal contribution to visibility impairment, but sulfates have an important role. Therefore, NO_x emission controls involving SCR are relatively ineffective in this case, especially taking into account the high cost of the controls.

NPS: Once again, AECOM has misrepresented the benefits of SCR by averaging impacts across all 16 Class I areas. According to AECOM results, Option 3 would reduce FCPP's impacts by 0.95 dv at Weiminuche WA and by 9.93 dv across the 16 Class I areas.

APS SCR Option 3 Improvements versus Baseline Visibility Impacts predicted by AECOM

	8th High delta dv			
Class I Area	**2001**	**2002**	**2003**	**Average**
Arches NP	0.75	0.56	0.94	0.75
Bandelier WA	0.69	0.60	0.48	0.59
Black Canyon of the Gunnison WA	0.44	0.73	0.89	0.69
Canyonlands NP	0.52	0.50	0.71	0.58
Capitol Reef NP	0.63	0.56	0.58	0.59
Grand Canyon NP	0.64	0.27	0.34	0.42
Great Sand Dunes NM	0.34	0.83	0.59	0.59
La Garita WA	0.76	0.85	0.75	0.78
Maroon Bells Snowmass WA	0.46	0.43	0.50	0.46
Mesa Verde NP	0.56	0.31	0.45	0.44
Pecos WA	0.86	0.63	0.52	0.67
Petrified Forest NP	0.60	0.75	0.23	0.52
San Pedro Parks WA	0.65	0.76	0.68	0.70
Weminuche WA	0.78	1.06	1.02	**0.95**
West Elk WA	0.51	0.79	0.68	0.66
Wheeler Peak WA	0.57	0.61	0.49	0.56
Totals	9.75	10.23	9.82	**9.93**

We also want to clarify some issues raised by AECOM. First, our mission is to preserve and protect our national parks for the enjoyment of all visitors, not just those who come during the peak visitation seasons. And, while it is true that addition of SCR will increase direct sulfate emissions, as discussed in our comments on NGS, addition of SCR and the subsequent oxidation of SO_2 and capture of that oxidized H_2SO_4 in the downstream air-preheater and FGD scrubber results in a net reduction of atmospheric sulfate.

We ran CALPUFF using APS' estimates for SO_2 and NO_x emissions and our estimates for SO_2 and PM emissions and for background ammonia. Our results were consistently higher than those of AECOM, and the greatest improvement would be at Weminuche WA at 3.59 dv. The cumulative improvement would be 27.25 dv. (Please see the enclosed map titled "Visibility Improvement at Class I Areas from SCR Controls at Four Corners PP.")

SCR Option 3 Improvements versus Baseline Visibility Impacts predicted by NPS

Class I Area	8th High delta dv			
	2001	**2002**	**2003**	**Average**
Arches NP	2.936	2.622	2.197	2.585
Bandelier W	1.550	1.920	1.636	1.702
Black Canyon of the Gunnison W	1.753	1.939	1.987	1.893
Canyonlands NP	4.144	3.677	2.951	**3.591**
Capitol Reef NP	2.854	1.819	1.302	1.992
Grand Canyon NP	2.078	1.157	0.859	1.365
Great Sand Dunes NM	0.681	0.958	0.811	0.817
La Garita W	0.897	1.169	1.317	1.128
Maroon Bells Snowmass W	0.695	0.720	0.828	0.748
Mesa Verde NP	2.221	2.713	2.826	2.587
Pecos W	1.085	1.558	1.059	1.234
Petrified Forest NP	0.948	1.319	0.514	0.927
San Pedro Parks W	2.425	2.049	2.181	2.218
Weminuche W	1.643	1.251	1.551	1.482
West Elk W	1.561	2.236	1.894	1.897
Wheeler Peak W	1.223	1.197	0.836	1.085
Totals	**28.694**	**28.304**	**24.749**	**27.249**

Determine BART

According to B&V, "Section 7.0 outlines the result of the cost impact analysis, but **the final determination of the BART technology will be dependent on the cost per deciview improvement** for the NO_X BART." We agree and will show that analyses of costs and visibility improvements that are conducted in a manner consistent with EPA's BART Guidelines leads to a conclusion that SCR is BART for FCPP Units #1 - #5.

Based upon our reviews of BART analyses across the U.S., we believe that cost-per-deciview ($/dv) of visibility improvement is the most-common and most-useful parameter. Our compilation[12] of BART analyses across the U.S. reveals that the **average cost/dv proposed by either a state or a BART source is $10 - $17 million**,[13] with a maximum of almost $50 million/dv proposed by Colorado at the Martin Drake power plant in Colorado Springs. Using the information provided by APS, we calculated the cost-effectiveness of its proposed combustion control option in $/ton and $/dv. We also calculated a "Pollutant Control Effectiveness" parameter, which is simply the visibility improvement (in dv) divided by the annual emission reduction (in tons). We have assumed that this parameter is the same for each EGU at FCPP, despite some differences in stack parameters and effective stack heights, because of the long distances to the affected Class I areas.

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[12] http://www.wrapair.org/forums/ssjf/bart.html

[13] For example, PacifiCorp has stated in its BART analysis for its Bridger Unit #2 that "The incremental cost effectiveness for Scenario 1 compared with the baseline for the Bridger WA, for example, is reasonable at $580,000 per day and $18.5 million per deciview."

The following table shows that the combustion controls proposed by APS would result in 0.28 dv improvement at (La Garita WA). Relating this improvement to the 14,200-tpy plant-wide reduction to be achieved, we estimate a "pollutant effectiveness (PE) factor" of 20 x 10^{-6} dv/ton at that single Class I area. The cumulative benefit of the proposed combustion controls is 3.39 dv and the cumulative PE factor is 239 x 10^{-6} dv/ton. In effect, cumulative benefits are about 12 times greater than the maximum single-area benefit. Application of these PE factors to each EGU and its expected emission reductions allows us to estimate the visibility improvement resulting from the proposed controls on each EGU without modeling each separately. The cumulative cost-effectiveness of the proposed combustion controls is $1.4 - $3.3 million/dv, depending upon the EGU.

APS Estimates of Proposed Combustion Control Cost-Effectiveness

Unit	**FCPP #1**	**FCPP #2**	**FCPP #3**	**FCPP #4**	**FCPP #5**	**Totals**
Cost-Effectiveness ($/ton)	$334	$545	$397	$792	$792	$690
Visibility Improvement (dv at Max Class I)	0.05	0.03	0.05	0.08	0.08	0.28
Cost-Effectiveness ($million/98th % dv at Max Class I)	$16.8	$27.4	$20.0	$39.9	$39.9	$34.7
Pollutant Control Effectiveness (dv/ton)	0.000020	0.000020	0.000020	0.000020	0.000020	0.000020
Visibility Improvement (dv at Summed Class I)	**0.61**	**0.38**	**0.59**	**0.91**	**0.91**	**3.39**
Cost-Effectiveness ($milion/98th % dv at Summed Class I)	**$1.4**	**$2.3**	**$1.7**	**$3.3**	**$3.3**	**$2.9**
Pollutant Control Effectiveness (dv/ton at Summed Class I)	**0.000239**	**0.000239**	**0.000239**	**0.000239**	**0.000239**	**0.000239**

The following table shows that the combustion controls plus SCR rejected by APS would result in 0.95-dv improvement at (Weiminuche WA). Relating this improvement to the 37,600-tpy plant-wide reduction to be achieved, we estimate a "pollutant effectiveness (PE) factor" of 25 x 10^{-6} dv/ton at that single Class I area. The cumulative benefit of the proposed combustion controls is 9.93 dv and the cumulative PE factor is 264 x 10^{-6} dv/ton. Application of these PE factors to each EGU and its expected emission reductions allows us to estimate the visibility improvement resulting from the proposed controls on each EGU. The cumulative cost-effectiveness of the proposed combustion controls is $12.7 - $17.4 million/dv, depending upon the EGU. Because these values fall at or below the $17 million/dv "reasonable cost" benchmark that we noted before, we believe that combustion controls plus SCR is BART for each EGU.

APS Estimates of Combustion Control + SCR Cost-Effectiveness

Unit	FCPP #1	FCPP #2	FCPP #3	FCPP #4	FCPP #5	Totals
Cost-Effectiveness ($/ton)	$3,371	$4,374	$3,914	$4,603	$4,603	$4,311
Visibility Improvement (dv at Max Class I)	0.13	0.11	0.13	0.29	0.29	0.95
Cost-Effectiveness ($million/98th % dv at Max Class I)	$132.7	$172.2	$154.1	$181.2	$181.2	$169.7
Pollutant Control Effectiveness (dv/ton)	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025
Visibility Improvement (dv at Summed Class I)	**1.39**	**1.15**	**1.34**	**3.03**	**3.03**	**9.93**
Cost-Effectiveness ($million/98th % dv at Summed Class I)	**$12.7**	**$16.5**	**$14.8**	**$17.4**	**$17.4**	**$16.3**
Pollutant Control Effectiveness (dv/ton at Summed Class I)	**0.000264**	**0.000264**	**0.000264**	**0.000264**	**0.000264**	**0.000264**

We believe that APS has overestimated the costs and underestimated the benefits of SCR. When we modeled the full-SCR (Option 3) at 0.07 lb/mmBtu (and 1 ppb background ammonia) and compared the visibility benefits to the costs we estimated based upon methods recommended by EPA, we arrived at the following results.

NPS Estimates of Combustion Control + SCR Cost-Effectiveness

Unit	**FCPP #1**	**FCPP #2**	**FCPP #3**	**FCPP #4**	**FCPP #5**	**Totals**
Cost-Effectiveness ($/ton)	$1,326	$1,882	$1,390	$1,453	$1,598	$1,516
Visibility Improvement (dv at Max Class I)	0.497	0.393	0.494	1.157	1.050	3.591
Cost-Effectiveness ($/98th % dv at Max Class I)	$14.5	$20.6	$15.2	$15.9	$17.5	$16.6
Pollutant Control Effectiveness (dv/ton)	0.000091	0.000091	0.000091	0.000091	0.000091	0.000091
Visibility Improvement (dv at Summed Class I)	**3.77**	**2.98**	**3.75**	**8.78**	**7.97**	**27.249**
Cost-Effectiveness ($/98th % dv at Summed Class I)	**$1.9**	**$2.7**	**$2.0**	**$2.1**	**$2.3**	**$2.2**
Pollutant Control Effectiveness (dv/ton at Summed Class I)	**0.000692**	**0.000692**	**0.000692**	**0.000692**	**0.000692**	**0.000692**

Our estimates show that the combustion controls plus SCR would result in 3.59 dv improvement at (Canyonlands NP). Relating this improvement to the 39,400-tpy plant-wide reduction to be achieved, we estimate a PE factor of 91 x 10^{-6} dv/ton at that single Class I area. The cumulative benefit of the proposed combustion controls is 27.25 dv and the cumulative PE factor is 692 x 10^{-6} dv/ton. (If one compares the PE factors that result from the AECOM models to the corresponding PE factors from our modeling, it appears that our results predict that it is two-to-four-times more beneficial to remove a ton of NO_x at FCPP than indicated by the AECOM results.) Application of these PE factors to each EGU and its expected emission reductions allows us to estimate the visibility improvement resulting from the proposed controls on each EGU. The cumulative cost-effectiveness of the proposed combustion controls is $1.9 - $2.7 million/dv, depending upon the EGU. Because these values fall well below the $17 million/dv "reasonable cost" benchmark that we noted before, the weight of evidence shows that combustion controls plus SCR is BART for each EGU.

We recognize that there are considerable uncertainties and differences between the B&V cost estimates and those we produced based upon the EPA Control Cost Manual approach. In an attempt to produce a "middle-ground" estimate, we have combined the APS/B&V cost and emission reduction estimates for combustion controls plus SCR with the PE factors from our modeling results.

APS Estimates of CC + SCR Control Cost + NPS Cost-Effectiveness

Unit	FCPP #1	FCPP #2	FCPP #3	FCPP #4	FCPP #5	Totals
Cost-Effectiveness ($/ton)	$3,371	$4,374	$3,914	$4,603	$4,603	$4,311
Visibility Improvement (dv at Max Class I)	0.48	0.40	0.46	1.04	1.04	3.43
Cost-Effectiveness ($/98th % dv at Max Class I)	$36.9	$47.9	$42.9	$50.5	$50.5	$47.3
Pollutant Control Effectiveness (dv/ton)	0.000091	0.000091	0.000091	0.000091	0.000091	0.000091
Visibility Improvement (dv at Summed Class I)	**3.65**	**3.00**	**3.50**	**7.92**	**7.92**	**26.00**
Cost-Effectiveness ($/98th % dv at Summed Class I)	**$4.9**	**$6.3**	**$5.7**	**$6.6**	**$6.6**	**$6.2**
Pollutant Control Effectiveness (dv/ton at Summed Class I)	**0.000692**	**0.000692**	**0.000692**	**0.000692**	**0.000692**	**0.000692**

Even though the APS emission reductions are lower (leading to lower visibility benefits and the APS cost estimates are higher than our estimates, the results show that **combustion controls plus SCR are cost-effective for all FCPP EGUs at $4.9 - $6.6 million/dv.**

NO_x BART Conclusions

We believe that a valid "top-down" approach to reducing NO_x demonstrates that combustion controls plus SCR is BART for all five units at FCPP. We have conducted our own analysis using the procedures described in EPA's BART Guidelines and in EPA's Control Cost Manual.

- APS has underestimated the ability of modern NO_x control systems. SCR is capable of reducing emissions below APS's target, and the amount of the reductions and consequent visibility improvements will increase.
- APS's SCR costs are overestimated and unsubstantiated. EPA guidance advises that its Control Cost Manual should be used; APS should follow this guidance. Use of EPA guidance and data results in a cost-effectiveness value for combustion modifications plus SCR of $1,300 - $1,900/ton, which appears reasonable for a source that impacts so many Class I areas.

- APS has underestimated the visibility benefits of SCR. APS should consider the cumulative effects of improving visibility across all of the 16 Class I areas affected. Our results estimate a cost-effectiveness value for combustion modifications plus SCR of \$1.9 - \$2.7 million/dv, which is much less than the average cost-effectiveness accepted by the states and sources we have surveyed. Even when we combine APS's estimates of control effectiveness and costs with our modeling results, combustion controls plus SCR are cost-effective for all FCPP EGUs at \$4.9 - \$6.6 million/dv.
- Because none of the NO_x control strategies evaluated would eliminate FCPP's significant impact upon visibility, additional analyses should be conducted to evaluate the costs and benefits of more comprehensive control strategies (e.g., upgraded SO_2 and/or particulate controls) to reduce visibility degradation.

PM BART

EPA is requesting comment on whether the existing controls on Units #1 – #3 at FCPP meet BART for PM. However, it is not clear how the 0.05 lb/mmBtu emission limit proposed as BART for these units by APS represents BART when the emissions data used by B&V were 0.024 – 0.029 lb/mmBtu in its engineering analysis, and AECOM used 0.014 – 0.017 lb/mmBtu in its modeling analysis. If APS believes that 0.05 lb/mmBtu is BART, it must conduct its analyses on that basis.

EPA should explain why it did not include Units #4 & #5 in its request, especially since Unit #4 has the highest filterable PM emissions of any of the five units. We note that the Desert Rock permit issued by EPA Region 9 contained a limit on filterable PM_{10} of 0.010 lb/mmBtu, and suggest that this would represent the starting point for a proper top-down BART analysis.